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The plural of 'anecdote' can be 'data': statistical analysis of viewing distances in reports of unidentified large marine animals 1758–2000

C. G. M. Paxton

Research Unit for Wildlife Population Assessment, Centre for Research into Ecological and Environmental Modelling, University of St Andrews, St Andrews, Fife, UK

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Correspondence
C. G. M. Paxton, Research Unit for Wildlife Population Assessment, Centre for Research into Ecological and Environmental Modelling, University of St Andrews, The Observatory, Buchanan Gardens, St Andrews, Fife KY16 9LZ, UK.
Email: cgp2@st-andrews.ac.uk

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Abstract

Analysis of the nearest reported distance in accounts of seemingly unknown, large, marine animals (sea monsters) by boat- or water-based eyewitnesses, revealed that, contrary to expectation, the majority of sightings were at close distance (<200 m). This suggests that misidentification of inanimate objects or known animal species due to great distance was unlikely. Assuming a uniform distribution of objects around the boat, the reported sightings were far closer than expected, implying a bias in the sighting or reporting process. The distribution of reported distances from boat- or water-based eyewitnesses was almost identical to that of shore-based witnesses. Unidentified large marine animals were more likely to be reported to be closer if the report was anonymous or secondhand. The gap of time between recollection/reporting and the actual sighting did not influence reported distance. There was no relation between reported distance and reported length. There was some equivocal evidence that the absence of a stated distance in a report might be an indicator of a hoax.

Introduction

Many low frequency, albeit important, natural phenomena such as meteorites (Burke, 1986), sprites (luminous disturbances above thunderclouds, Boeck *et al.*, 1998) and rogue waves (Draper, 1964) have been initially reported only as anecdotes. In a zoological context, eyewitness accounts have been used to date the probable extinction of the dodo (Roberts & Solow, 2003; Hume, Martill & Dewdney, 2004), the Danubian population of the Atlantic sturgeon (Jarić *et al.*, 2009) and the Atlantic population of the grey whale (Mead & Mitchell, 1984; Bryant, 1995), as well as the possible persistence of the Caribbean monk seal (Boyd & Stanfield, 1998). Another type of zoological anecdote is reports of large unidentified animals. Unlike anecdotal accounts of known animals, such eyewitness accounts have been considered to be, at best, a start point for investigation, but mostly an irrelevance (e.g. Shermer, 1997, 2003), as actual evidence for unknown species.

In the marine environment, large (>2 m) marine animals are still being described (Paxton, 1998). Such animals are not just new, genetically determined, cryptic species rescued from synonymy [e.g. the Australian snubfin dolphin *Orcaella heinsohni* described in 2005, Beasley, Robertson & Arnold; a new rorqual *Balaenoptera omurai* described in 2003, Wada, Oishi & Yamada; *Mesoplodon perrini*, a new species of beaked whale described in 2002 (Dalebout *et al.*)]; but also clearly morphologically new species [e.g. *Bathyraja hesperafricana*, a giant benthic ray described in 1995 (Stehmann)]. Therefore, it is reasonable to at least, consider whether some reports of large unidentified marine animals could represent genuine sightings of unknown species.

Evaluation of such reports has been primarily qualitative and subjective (e.g. Oudemans, 1892; Heuvelmans, 1968) but there is quantitative information within unknown animal reports that does allow statistical conclusions to be drawn *as long as it is realized that the raw data are reports of sightings subject to a variety of biases, and not necessarily accurately recalled sightings of animals known or unknown. Thus the conclusions should be constrained appropriately*. If anecdotes are to be used as data, the biases in the dataset need to be identified.

As modern zoological nomenclature starts in 1758, with the definitive 10th edition of Linnaeus' *Systema Naturae*, it is only from then that a meaningful distinction between a species being known or unknown to the scientific community can really be made. Since that time there have been several hundred published reports of sea monsters world wide (e.g.

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such compilations as Heuvelmans, 1968; Dinsdale, 1976; O'Neill, 1999; LeBlond & Bousfield, 1995; Harrison, 2001). Here I analyse the nearest reported distance (NRD) of observers to sea monsters (i.e. large unidentified objects or animals seen at sea and presumed by the reporting witnesses to be of an undiscovered large marine species).

Five questions were under consideration. The first query was whether large unidentified marine animal reports are due to misidentifications of animals and objects at a distance. If so, it might be expected that more sightings (and hence reports) would occur at a distance rather than close to the observers.

Given that the distribution of animals from a boat in the open sea should, on average, be uniform around the witness (assuming no boat attraction/avoidance) over the range of vision, then the second hypothesis was that sightings from the shore would be further away than sightings from the open sea as most large marine animals are not found in very shallow water.

The third question was whether anonymous and secondhand accounts were associated with closer reported distances because of hoaxing, exaggeration or a Chinese whispers effect. A related question was suggested by Wiseman & Lamont's (1996) analysis of eyewitnesses' historical accounts of the Indian rope trick. They found the longer the time until recall, the more flamboyant the recollection. As the time to recollection in large unknown marine animal reports show a large variation, it might seem plausible that a similar effect may be seen in NRD.

A further hypothesis arose from a casual observation from a book (Cassie, 1935) of purported, frequent but obviously impossible monster sightings from Loch Achanalt, Scotland. Cassie's reports were flamboyant (e.g. animals in excess of the length of the lake) and frequent (sometimes daily), but not reported by anyone else nor clearly photographed either. Almost none of these sightings were associated with any indication of the distance of the monster to the witness. This suggested that unreliable (i.e. observer was insincere or irrational rather than inaccurate or mistaken) monster accounts might be associated with the omission of a reported distance perhaps as liars/fantasists might have less of a tendency to relate themselves to what was seen, as compared with a genuine witness of an anomalous event. This reflects what is known from the psychological literature, where liars tend to avoid self-reference (Wiseman, 2008).

A final question considered the relationship of reported distance to reported length, to see if any unusual patterns in the data could be detected. Smaller animals will typically have a lower probability of detection at larger distances than larger ones (Buckland *et al*., 2001) and hence not be reported. Therefore, assuming no reporting biases, there should be a relationship between reported distance and estimated animal size.

Thus four distinct statistical investigations were undertaken. The first investigation simply considered the frequency distribution of reported sighting distances of large unknown marine animals from boat-based witnesses and what factors might drive that distribution in terms of availability of animals and detection ability of witnesses. The second analysis considered whether the distribution of distances was affected by location (on board a boat, on the shore or unstated), anonymity, handedness of reports or the gap of time between the encounter and recollection. The third investigation considered whether the presence of sighting distance in a report could be used to assess the veracity of the witnesses in combination with other variables, that is handedness of the report and anonymity of observers. Finally, the effect of reported distance on estimated length was considered.

Methods

In each of the four investigations, the data were based on a subset of a compilation of large unknown marine animal accounts, made by the author, from various primary and secondary sources, including books, newspaper accounts and personally collected testimony. Only reports from 1758 onwards were considered. The primary variable of interest was the NRD of the unidentified animal to the observer. Note that the NRD may not reflect the actual distance of the observer to what was seen.

Analysis was initially carried out on the subset of not demonstrably hoaxed marine reports for which a NRD of the observer to the animal was recorded. Logbook accounts were considered to be firsthand as they are legal documents. Carcasses that were not delivered to scientific authorities are considered to be reports with distance zero. No effort was attempted to distinguish between truthful and as yet unexposed insincere accounts until the third analysis, except that analysis one and two were carried out on both all NRDs, as well as a subset of these data with non-zero NRDs. This was because a number of the zero distance reports were somewhat flamboyant accounts of capture, collision and attack. As the datasets fluctuate for each analysis, Table 1 summarizes the numbers involved.

Reports came from observers on land, on boats, in the water or location unstated. Boat- and water-based reports were considered as one class of report (hereafter for simplicity 'boat' reports) and land- and ice-based reports were considered as 'shore' reports. Reports could be distinguished by the presence or not of a reported distance, by anonymity (Y/N), location (boat or shore) and handedness of report (firsthand or secondhand). For a subset of the data where the date of observation and date of report was firmly known, the time period between the two could be calculated. Primary accounts were considered to be first person quotes from witnesses and logbooks. Second or third person reports, hearsay, etc. were considered secondary. Anonymous accounts were classified as such if the witness was described as unnamed, a generic member of the crew or a relative of another named person. Unsurprisingly, anonymous reports tended to be secondhand, so these two factors were then confounded in subsequent analysis.

Years where date was uncertain were either classified as unknown or a midpoint of the plausible range was taken.

Distances had to be given in the form of explicit numbers to be included in the analysis, except for some of the zero distance accounts, where a zero distance was implied by

Table 1 Sightings data available for each analysis (numbers in parentheses are numbers for final selected models, see 'Results')

Analysis	*n*	Description
Figure 1a and b	165	All independent accounts of boat (see text) NRDs. No reports exposed as hoaxes included but includes suspected hoaxes
	147	As above but with all zero distance reports removed
Regression of NRD on location, anonymity or handedness	78 (325)	All independent accounts of boat, shore or location unstated NRDs. No reports exposed as hoaxes included but includes suspected hoaxes
	69 (264)	As above but with all zero distance reports removed
Logistic regression, presence of a hoax on presence of an NRD, handedness and anonymity and time to report	429	All independent accounts of boat, shore or location unstated encounters with or without distances as listed and categorized by Heuvelmans (1968). Includes both suspected and confirmed hoaxes. Reports where distance explicitly asked for not included
	390	As above but with all zero distance reports removed
Regression of estimated length on NRD	173	All independent accounts of boat, shore or location unstated NRDs with estimated lengths. No sightings exposed as hoaxes considered but includes suspected hoaxes

NRD, nearest reported distance.

Table 2 Factors influencing the distribution of nearest reported distances to large unknown marine animals

Distribution of distances towards the observer	Distribution of distances away from the observer
Boat attracts unidentified marine animals	Boat deters unidentified marine animals
Witnesses underestimate distances	Witnesses overestimate distances
Witnesses or others do not report sightings made at a distance	Identification of animals as unknown increases with distance
Witnesses or others minimize distance for dramatic effect	Increased search field of ocean leads to more sightings away from the observer
Decreased detection ability with distance	
Witnesses approach monsters	
Witnesses only search for objects close to themselves (unlike a survey)	
Nearest reported distances only considered	

capture or contact. If the distances were described as miles, they were assumed to be nautical miles (= 1852, 1853 m for the Royal Navy) if the observation was made by a sailor, and land miles (= 1609 m) if made by a land lubber. In the case of witnesses of multiple unidentified marine animal encounters, only a single incident was considered for each witness and if there were multiple witnesses to a single sighting of an unidentified animal, only the first account encountered was considered. Thus all reports were assumed to be independent. There remains a risk that reports were still not wholly independent, as distinct reports can come from the same textual source (e.g. a letter, etc.), and witnesses may be influenced by previous personal experiences and reports by others.

If a description of a distance was given as 'less than r' the distance was taken as r. Likewise 'at least r' was taken as r.

Frequency distribution of reported sighting distances from boats

If the observed animals were indifferent to the presence of a boat and assuming no local habitat preferences, then the underlying distribution of actual animals around a vessel would be expected to be uniform. Nonetheless this would have not lead to uniform distribution of *reported* distances even if distance estimation was accurate. Point sampling theory (see Buckland *et al.*, 2001) suggests that the majority of sightings should have been a middling distance from the observer as a result of the combination of both visual detectability (declining with distance) and increasing available observable sea surface (area increases as the square of distance observed, from πr^2). Other factors that could influence the distribution of reported distances are given in Table 2.

Effects of location, handedness, age of report and anonymity on reported distances to unidentified large marine animals

If large unknown marine animals are deeper water animals, then it might be expected that the sightings from the shore would be at greater distance than sightings from boats. The uniformity assumption made above, for boat-based sightings would not hold as many large marine animals would presumably avoid shallow water.

Therefore to investigate whether observed location (shore, boat or unstated), anonymity, handedness and time until report (treated as a factor with five levels) affected reported distances, the ranked reported distances were analysed as the dependent variable in a four-way analysis of variance. The analysis was performed in the statistical package *R* (R Development Core Team, 2007). Analysis was performed on both the total number of reports where distance was reported and

also the subset of non-zero distance accounts. As predictor variables were reduced, it was possible to add more data to the analysis as not all distances had a full set of associated location, gap times, anonymity or handedness (see Table 1).

Veracity and reported observation distances

Absolute sincerity of witnesses is almost impossible to gauge in most instances. Sometimes hoaxes were confessed to, or demonstrated as false but this is rare within the marine database. Veracity can reasonably be assumed if there is a description of a then unknown animal that vividly describes a species now known (e.g. Lieutenant W. Foley's 1834 description of a flattened, spotted whale-sized animal with a large dorsal in the Indian Ocean, clearly a whale shark, Foley, 1835). The ship's official logbook is a legally required document (Hardy Ivamy, 1984), thus logbook accounts should perhaps be assumed to be true unless there is evidence to the contrary. As the number of such accounts of clear veracity is negligible, but to provide an independent assignment of truth or falsehood to reports, I used the large unknown marine animal report compendium of Heuvelmans (1968).

Heuvelmans (1968), in an appendix, stated whether he thought his listed reports were hoaxes or not using a criterion that was never explicitly described, but was presumably subjective and qualitative rather than statistical, although internal inconsistency was sometimes applied as well as biological implausibility. He had a third class of observation whose affinities he could not place as there was insufficient information. These reports were omitted. Omitting Heuvelmans' (1968) undecided reports had the further advantage of controlling for sightings where there was a simple overall lack of information. The label 'hoax' for Heuvelmans (1968) could indicate a variety of situations, only some of which would be a lack of truthfulness on the part of the witness. Only Heuvelmans' (1968) belief in the witness' insincerity were considered, that is the report was false, rather than the witness was being fooled by a third party. Thus a report where the animal reported could subsequently be reasonably identified as a known species were included, as it was reasonable to assume that the witness were being truthful even if ignorant of the animal's true identity.

The data were analysed as a logistic generalized linear model (e.g. Dobson, 1990) with hoaxed or not as the dependent variable and anonymity, handedness and whether or not a nearest approach distance was reported as predictors. The analysis was performed in *R*. In this analysis, reports where it was known that the NRD to the unidentified marine animal was specifically asked for by investigators, were omitted from the analysis [e.g. all sea serpent accounts with a sighting distance that were collected as part of the investigation by the Linnaean Society of New England in 1817 (Anonymous, 1817)]. Extra effort was taken to go to as many primary sources of putative hoaxes to obtain as many distances, as possible, to make the null hypothesis difficult to reject. Disproportionately many (see 'Results') of the Heuvelmans-defined hoaxes with reported distances, had an effective reporting distance of zero. Thus an analysis was also performed on a subset of the data omitting the sightings with distance zero.

Reported length and reported distance

Length is a frequent descriptor given in large unknown marine animal accounts in the database. Typically either estimated length of body out of the water or estimated total length is reported by observers. Often these different types of estimate are not distinguished. In this case the larger of any length estimate was given and regressed against the reported estimated distance.

Results

Frequency of reported distances from boats

The frequency histogram of the reported distances is given in Fig. 1a and b. It is a strongly spiked, right-skewed distribution with few reported observations beyond 200 m. Over 50% of reported sightings are within 100 m of the observer. There is also evidence of rounding with lesser modes at distances corresponding to round numbers in non-SI units (i.e. 100, 150, 200 yards, 1 mile and 1 nautical mile, etc., Fig. 1a). Thus there was absolutely no evidence that the mass of the observations were at a distance because of the greater search field and misidentification of known animals as unknown. This pattern remained even if the zero distance data were not considered (Fig. 1a and b).

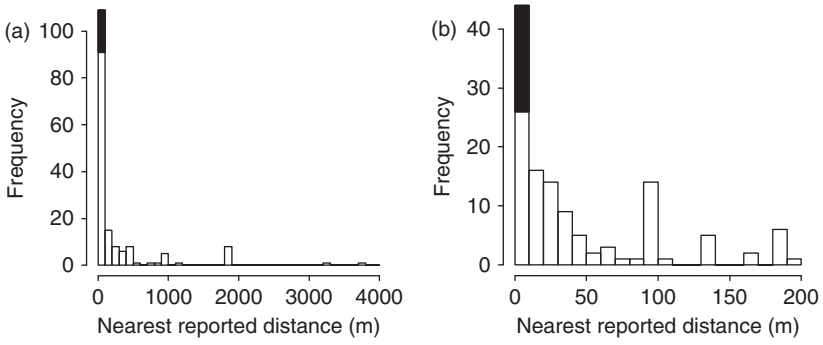

Figure 1 Nearest reported distances from boats across (a) whole range (bins 200 m), (b) 0–200 m (bins 10 m). Black indicates component made up of sightings of distance zero.

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Effects of location, handedness and anonymity on reported distances to unidentified large marine animals

Surprisingly, there was no evidence that location (boat, shore or unstated) or time until reporting had any effect on NRD. There was evidence that the reports being secondhand decreased reported distance ($F_{1,322} = 17.51$, $P < 0.001$), as did anonymity ($F_{1,322} = 10.54$, $P = 0.001$). No significant predictors of NRD were found if reported distances of zero were omitted from the analysis. This is not wholly unsurprising as there was an association of whether a report was secondhand or not, as well as anonymity with a reported distance of zero (handedness and zero distance: $\chi^2 = 22.69$, d.f. = 1, $P < 0.001$, anonymity and zero distance: $\chi^2 = 49.74$, d.f. = 1, $P < 0.001$).

Validity and NRDs

Four hundred and twenty-nine accounts designated hoaxed or true in Heuvelmans (1968) were in the database where a distance estimate had not been requested by any recording authority. Of these 429, 186 were associated with reported distances to the observed animal.

Analysis using the logistic generalized linear model with hoaxed or not as the dependent variable and presence of an NRD, anonymity and handedness as potential predictors suggested that anonymity was a predictor of whether Heuvelmans designated a report a hoax ($P < 0.001$). The P value associated with whether the presence of an NRD in the report predicted a truthful account was 0.052, suggesting that this hypothesis should perhaps be investigated further. Similar results were found even if the zero distance reports were omitted from the data.

Reported length and NRD

Estimated lengths in the full set of reports varied between 0.914 m (1 yard) and 5556 m (an extraordinary estimate of 3 nautical miles!). Only 173 reports had combined length and distance estimate (Fig. 2), with the 5556 m result omitted. A variety of models were considered for the relationship of reported seen or estimated length to NRD but, surprisingly, no relationship was found.

Discussion

The most immediate consideration in analysing the large unknown marine animal reports database was how few reports actually have any meaningful descriptive details including such basic detail as estimated distance to the reported animal.

It was expected that most large unknown marine animal accounts would be attributable to misidentification caused by distance. The results do not suggest this occurs in anything but a small minority of cases, unless non-recognition takes place at only a few tens of metres. The majority of unidentified large marine animal sightings are reported to be < 100 m away. It has been assumed by some writers (Oudemans, 1892; Gould, 1930) and witnesses (see the account by James Prince in O'Neill, 1999) that sea monsters are 'timid' animals that avoid human beings. There is no evidence for this.

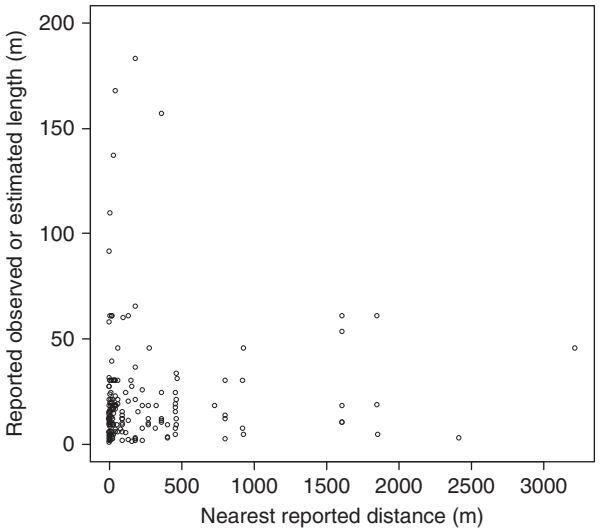

Figure 2 Reported length and distance for large unknown marine animal reports 1758–2000 with one outlier omitted.

Determining from the accounts themselves, which combination of the factors in Table 1 led to the closer than expected distribution of distances is difficult. There are accounts where the boat upon seeing the potential monster advanced closely (e.g. the gunboat *Avalanche* in 1898 and the frigate *Boston* in 1780, Heuvelmans, 1968). That observers overestimate distances across water landscapes is well established in the marine mammal survey literature (e.g. Williams *et al.*, 2007) and presumably the same bias affects casual observers from boats (possibly even more so). However, where seen, the level of bias introduced by such overestimation of distance (e.g. actual distance = estimated distance$^{1/1.042}$, Williams *et al.*, 2007) is not so much as to generate the strongly spiked distribution of distances seen here. It could be biases have arisen because of the reporting process itself is a complex question. It may be that a filtering occurs, in that an object seen is not considered as a monster because of the distance involved, or is not considered worth reporting. Or the bias could be made by media outlets: monster observations at great distance are simply never made public. Thus the observed pattern of reported distances could be caused by a number of processes. Further evidence that there is a bias caused by the reporting process, is supported by the failure to find any relation between estimated size of animal seen and estimated distance. Any bias in the analysis caused by considering only *nearest* approach distances is difficult to estimate because boats are not moving randomly with regard to any putative monsters.

The surprising result that the shore-based observations were at no greater distance from the observer than boat and water-based observations, implies that what is being observed from the shore is not essentially different from what is being observed from boats, at least in terms of

underlying distribution of reported objects. If the majority of shore-based large unknown marine animals sightings were of genuine large marine animals, it might be expected that the shore-based observations should be at a greater distance than boat-based observations, reflecting an avoidance of shallow water. That this is not the case, implies that either shore-based observers are not really seeing deep water animals or perhaps that, again, biases introduced in the reporting process swamp any biological-based pattern in NRDs. Unlike the open water case, a shore-based observer has only a limited ability to decrease his or her distance to the monster.

Second handedness and anonymity decreased the reported distance, implying that hearsay is unreliable in the case of large unknown marine animal reports. Interestingly, Wiseman & Lamont's (1996) observations of exaggerations in the reported details of an unusual experience over the passing of time was not found here. Why this was so is unclear.

The results of the logistic regression suggest that anonymity is the best predictor of veracity [at least what Heuvelmans (1968) believed to be veracity]. The unprompted presence of an observation distance in a large unknown marine animal account may be an indication of its truthfulness.

Given the misinterpretations and inaccuracies of recollection that are associated with eyewitness testimony even when what is witnessed is known (e.g. Loftus, 1996), it is impossible to determine, for all but a small number of sightings, exactly whether the witness is telling the truth. Such unequivocal marine sightings (i.e. where it is beyond reasonable doubt the witnesses are lying or telling the truth, through confession or multiple witnesses or accurate description of a known animal) are too few for statistical analysis but it may be possible in the future to augment the marine sightings data with unequivocal freshwater sightings data, to see what other cues may be used for predicting eyewitness veracity. Ultimately, the hypothesis that reporting distances is associated with witness veracity should be tested under experimental conditions where it can be unequivocally known whether the witnesses are lying or not.

That no relationship between reported distance and estimated length was found is in disagreement to the animal survey literature where such a relationship is often found (Buckland *et al*., 2001). Again, the failure to find such a relationship could be due to observers approaching the monster in the case of boat-based accounts, but this does not hold for shore-based accounts. The mixture of estimated total length and estimated seen lengths may also account for the lack of a length–distance relationship.

It has been argued that anecdotes are not amenable to scientific analysis and hence that anecdotal evidence for anomalous phenomena cannot be used as evidence (e.g. Shermer, 2003). However, if limits are placed on the conclusions that can be drawn, anecdotes of anomalous phenomena can be considered data. Nevertheless it is clear that the data itself is subject to error. For example, we have two wholly independent written accounts of the sea monster seen by the *SS Taiyuan* in the Celebes Sea in 1907 both dating several decades after the event with NRDs of '80 ft' (*c*. 24 m) and half a mile (*c*. 804 m), respectively (Heuvelmans, 1968; Dinsdale, 1976)! It should never be forgotten that although the analysis of sea monster reports allows conclusions to be drawn about reported sea monsters, it allows at best only tentative conclusions about actual sea monsters. What is reported is different to what is remembered which is different to what was seen which is different to what was present.

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